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LLNL-TR-661758

Apodizers Record of Invention 1978

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September 30, 2014

Disclaimer

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

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Interdepartmental letterhead

Mail Station L- 488

Ext: 25489

TDA 78-038
March 1, 1978

TO: John Holzrichter

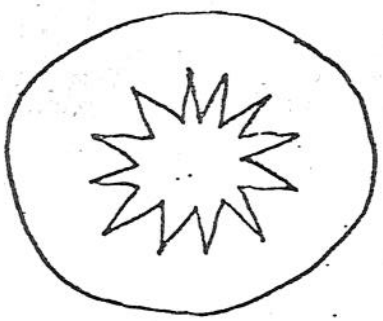
FROM: John B. Trenholme

SUBJECT: Apodizers

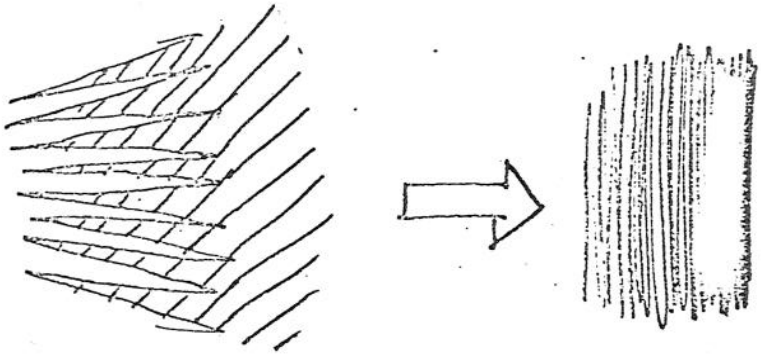
It is apparent from the Shiva beam photos that this laser is so clean that we are back to the point where most of the noise is coming from the hard-aperture "apodizer" rather than from the dirt in the laser. We need a softer beam shaper than the present washer. Film, evaporated metal, and absorbing glass apodizers suffer from low damage levels, long construction time, high cost, or a tendency to put noise on the beam (pick one or more). While contemplating this state of affairs, a thought appeared to me:

We can apodize by using a high-frequency pattern of variable area ratio, and then smoothing it with a spatial filter.

Suppose, for example, we cut or etch (or whatever) an apodizer with the following shape:

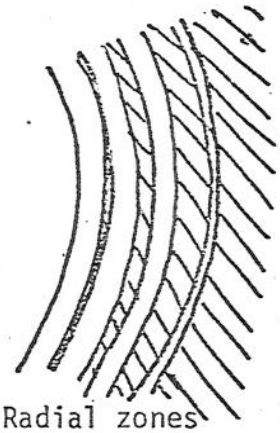


This has a central clear area, a transition zone, and an opaque outer region. If we use it as-is, the high frequency diffraction from the spokes will put huge irregularities on the beam, which will damage things. Now for part two: We go through a spatial filter! The spoke geometry and filter cutoff are set so that all high frequencies in the pattern are removed, and we are left with just the average transmission

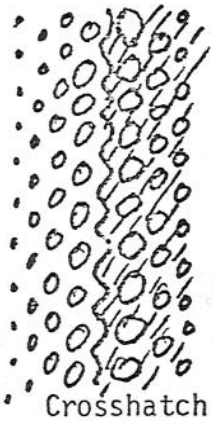


To do this well, we want the spokes to be much more closely spaced than the width of the transition zone, so that the spacing frequency is much larger than the frequencies in the apodizing function. We adjust the apodizing function by appropriate taper of the spokes:

Of course, we don't have to use spokes. Any pattern with variable transmission and features smaller than the transition zone size will work. For example:



Radial zones

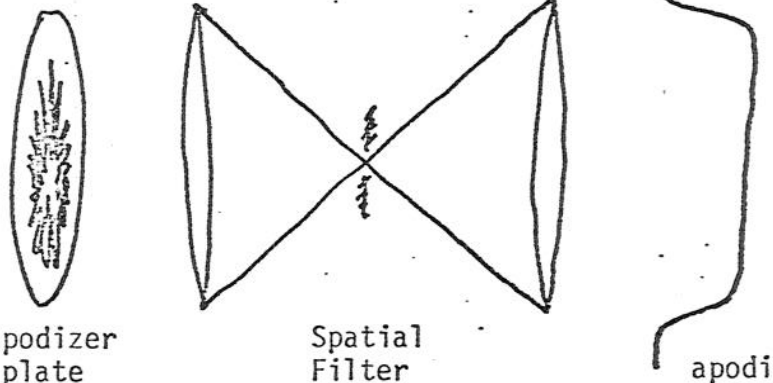


Crosshatch (halftone)

irregular blobs

etc.

The whole apodizer is then:



apodizer plate (etc.)

Spatial Filter

apodized beam

If we want, the apodizer can be inside the filter so the lens doesn't see the noisy beam (might damage). If we're at low power, a noisy beam is not a problem and we could have amplifiers or whatever between the apodizer and the filter.

The apodizer doesn't have to be a plate. Maybe a tube with fuzz on the inside or ... ?

John B. Trenholme

aeh
cc: J. Emmett
T. Gilmartin
A. Glass
R. Godwin
J. Hunt
J. Schipper, L-371
W. Simmons

FORM AEC-213 (4-66) AECPR 9-9

UNITED STATES
ATOMIC ENERGY COMMISSION
OFFICE OF ASSISTANT GENERAL COUNSEL FOR PATENTS

RECORD OF INVENTION

AEC CASE NO. IL-6447

This Record of Invention is an important legal document and proper care in its early and complete preparation will save important time and inconvenience in the future. The Instructions* on the back should be read carefully before filling in the data.

(A) INVENTOR: (1) NAME(S): John B. Trenholme

(2) TITLE OR POSITION: Physicist

(3) EMPLOYED BY: Lawrence Livermore Laboratory

(4) PERMANENT ADDRESS: 120 Montair Ct., Danville, CA. 94526

(B) TITLE OF INVENTION (*1): APODIZER

(C) DESCRIPTION OF INVENTION (*2):

A method to spatially smooth a laser beam by passing the beam through an apodizing aperture with a high frequency variable transmission pattern and then smoothing the beam with a spatial filter.

(D) DATES AND PLACES OF INVENTIONS:

(1) CONCEPTION BY INVENTOR (*3) February 1978 AT LLL

(2) FIRST SKETCH OR DRAWING March 1, 1978 AT LLL IN WORKBOOK Memo TDA 78-038 PAGE

(3) FIRST WRITTEN DESCRIPTION March 1, 1978 AT LLL IN WORKBOOK Memo TDA 78-038 PAGE

(4) DISCLOSURE TO OTHERS (*4) AT

(a) John Holzrichter February 1978 19 AT LLL

(b) John Hunt February 1978 19 AT LLL

(5) COMPLETION OF MODEL OR FULL SIZE DEVICE AT

(6) FIRST TEST OR OPERATION OF INVENTION AT

(E) RESULTS OF TESTS, AND EXTENT OF USE OF INVENTION (*5):

(F) NAMES OF ALL PERSONS HAVING KNOWLEDGE OF FACTS STATED UNDER (D) AND (E):

(G) PERTINENT REPORTS (*6):

None.

(H) OTHER CLOSELY RELATED PUBLICATIONS, PATENTS, AND PATENT APPLICATIONS (*7):

(I) RIGHTS OF U. S. GOVERNMENT:

To be determined by U. S. Department of Energy.

(J) LICENSES OR ASSIGNMENTS:

(K) CONTRACTS INVOLVED:

University of California

CONTRACTOR AND ADDRESS: Lawrence Livermore Laboratory P.O. Box 808, Livermore, California 94550

CONTRACT NO. W-7405-ENG-48 DATE:

TYPE OF CONTRACT: UNCLASSIFIED | RESTRICTED | CONFIDENTIAL | SECRET

(L) SIGNATURE OF WITNESS: Henry P. Sartorio DATE: 5-17-78

FORWARDED BY (*8)—

SIGNATURE OF INVENTOR(S): DATE: 17 May 78

DATE 5/18/78

(OVER)

DISCLOSURE

Invention Case No. IL-6447

(UC LLL)

Title : Apodizer

Inventor : John B. Trenholme

Abstract :

A method to spatially smooth a laser beam by passing the beam through an apodizing aperture with a high frequency variable transmission pattern and then smoothing the beam with a spatial filter.

Apodizer

Description:

An apodizing aperture is used to control the spatial amplitude profile of a laser beam to maximize the energy in the beam and effectively focus the beam onto a small target while minimizing beam breakup. By passing the center of the beam through a graded aperture, a nearly uniform beam with smooth edges is formed. Various types of apodizing apertures with a radial transmission gradient are presently used but they all are difficult and expensive to make, have low damage thresholds, and introduce noise into the beam.

The present invention is a method of apodizing a laser beam by passing the beam through an aperture with a high-frequency pattern of variable area ratio, and then smoothing it with a spatial filter. The aperture produces sharp changes in the beam intensity which are smoothed out by the following spatial filter. Details and examples of the apodizer geometry are shown in the inventor's memorandum TDA 78-038, copy attached.

The present invention can easily be fabricated from solid metal, probably by a photoetching process, so it has high damage resistance. It can be used with a high power laser unlike conventional apodizers. A variety of aperture shapes, e.g., square, can be used. The variable transmission pattern must be such that the frequencies produced do not go through the following spatial filter.

Sample Claim:

A method to substantially spatially smooth a laser beam, comprising:

passing the laser beam through an apodizing aperture with a high-frequency variable transmission pattern; and

smoothing the laser beam with a following spatial filter.

Possible Statutory Bars:

1. Publication

   None known.

2. Public Use

   None.

Prior Art:

Apodizing apertures with a radial transmission gradient are now employed. A photographic film aperture used at LLL is described in the Laser Program Annual Report-1974, pp. 135-138 and Fig. 4-13. A metallic-coated aperture, also used at LLL, is described in the Laser Program Annual Report-1975, pp. 138-140 and Fig. 4-5.

Probable Value and Extent of Use:

The present invention is simple and easy to fabricate. It should be useful on the Shiva laser to produce a spatially uniform beam profile. It could be applied to other laser systems where it is desirable to apodize the beam.

I believe myself to be the first and original discoverer of the invention disclosed above.

INVENTOR: _____ DATE: 17 May 78

Read and understood by:

Henry P. Sartorio DATE: 5-17-78

Henry P. Sartorio